

## **REMARKS**

Applicants respectfully traverse and request reconsideration.

Claims 10, 11, 13, 14, 15, 19, 23 and 28 have been amended. Each of these amendments corrects at least one of: typographical errors, antecedent basis errors or claim dependency errors. Accordingly, no new subject matter is believed to have been added.

Claims 1-11, 13-15, 19 and 23-30 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent Publication No. 2005/0134588 A1 to Aila et al (“Aila”) in view of U.S. Patent No. 5,579,455 to Greene et al. (“Greene”).

Claim 1 is directed to a method for hierarchical Z buffering and stenciling comprising, among other things, comparing a tile Z value range of a tile with a hierarchical Z value range and determining whether to render a plurality of pixels within the tile based, in part, on the comparison of the tile Z value range with the hierarchical Z value range. The current Office action alleges that Aila teaches identifying tile Z-min and tile Z-max values as part of defining a tile volume. (Office action, pp. 2-3; Aila, ¶ 53). The current Office action also admits that Aila “fails to explicitly teach a hierarchical Z value range for which to compare said previously disclosed [tile] Z value range with.” (Office action, p. 3). Finally, the Office action appears to allege that Greene teaches both a hierarchical Z value range and a tile Z value range. (Office action, pp. 3-5). Applicants agree that Aila fails to teach a hierarchical Z value range. Applicants further submit that Greene fails to teach a hierarchical Z value range and that no combination of the references teaches comparing a tile Z value range with a hierarchical Z value range. For these reasons, each of the independent claims appear to be in proper condition for allowance.

## Greene

Turning to Greene, the Office action cites the Z depth buffer (also referred to by Greene as a Z-pyramid, Z-buffer or depth buffer) of FIGs. 5 and 5A as allegedly containing components that are equivalent to the claimed hierarchical Z value range and the claimed tile Z value range. With reference to FIGs. 5 and 5A, the Z-pyramid is explained to be a conventional depth buffer at the finest (i.e., lowest) level 504 in the pyramid. (Greene, Col. 5, ll. 50-52). In this finest level 504, the Z-pyramid has a plurality of depth elements 512, each corresponding to a display cell (e.g. pixel) 204 of a display. (Greene, FIGs. 5, 5A; Col. 10, ll. 8-27). Each subsequently higher level represents a correspondingly courser level. (*Id.*). In the example of FIG. 5 and 5A, the second finest level 506 contains only a 4x4 array of depth elements 512, each of which “covers” or is “superior” to a respective group of four of the depth elements 512 in the finest level 504. Each depth elements 512 in level 506 represents the farthest Z value contained in any of the depth elements which it covers in level 504. The Z-pyramid shown in FIGs. 5 and 5A also illustrates depth levels 508 and 510. (Col. 10, l. 45 – Col. 11, l. 3). “At the coarsest level of the pyramid [i.e., the very top level 510] there is a single Z value which is the farthest Z from the observer in the whole image.” (Greene, Col. 5, ll. 56-59, emphasis added).

Put another way, each entry in the Z-pyramid of Greene represents the farthest Z or max-Z value for a square area of the Z-buffer. The lowest level is the most fine level, while the highest level is the most course level. In one embodiment, the Z-pyramid may contain not only Z-max values, but also Z-min values, where “for each Z-min element, the depth value is the nearest depth value in any of the Z-min elements which are covered by such Z-min element in the next finest granularity level.” (Greene, Col. 14, ll. 48-63, emphasis added).

Greene explains that the Z-pyramid can be used to determine if a given primitive is hidden or partially visible. (Greene, Col. 4, ll. 14-15; Col. 17, ll. 24-40). A primitive is hidden with respect to a Z-buffer if no pixel of the primitive is closer to the observer than the Z value already in the Z-buffer. (Greene, Col. 4, ll. 14-16). To make this determination, Greene finds “the finest-level sample of the pyramid whose corresponding image region covers the screen-space bounding box of the [primitive]. If the nearest Z value of the [primitive] is father away than the sample [i.e., the Z-max] in the Z-pyramid, [the primitive] is entirely hidden.” (Greene, Col. 5, l. 66 – Col. 6, l. 4). The Z-pyramid can also be used recursively to determine if the primitive is hidden in a given quadrant it intersects by going up a level in the pyramid when the basic test fails to show that a polygon is hidden. (Greene, Col. 6, ll. 21-26). Z-min values in the Z-pyramid may be used to determine if the particular primitive is at least partially visible. Greene teaches in Col. 17, ll. 24-40 that the Z-max value of the Z-pyramid is first compared to the nearest Z value of the primitive. If the primitive is not hidden, then the corresponding Z-min value of the Z-pyramid is compared to the same nearest Z value of the primitive to determine if the primitive is at least partly visible.

Turning now to the application of Greene to the claimed subject matter, Applicants note that the Office action appears to characterize the Z-max and Z-min values associated with any given “depth element” (i.e., element 512) in the Z-pyramid of FIGs. 5 and 5a as allegedly corresponding to tile Z values. (Office action, p. 4 and p. 11). Assuming for the sake of this response that this is true (a position not taken by Applicants), the Office action further states that “for each such Z-max element, the depth value which is written into that element is the farthest depth value in any of the Z-max elements which are covered by such Z-max element in the next finer granularity level of the depth buffer 502 (hierarchical Z value range).” (Office action, p. 4).

In other words, the Office action alleges that the Z-max and Z-min values of any particular depth element 512 in the Z-pyramid are equivalent to the claimed tile Z range, and that the Z-max and Z-min values in the next finer granularity level of the same Z-pyramid somehow represent a hierarchical Z value range. This constitutes clear error for at least two reasons: (1) it is inconsistent; and (2) the Z values in the next finer granularity levels are not compared with any alleged tile Z values as required by the claims.

The Office action's characterization is inconsistent because each (not just some) depth element 512 and its corresponding Z values in the Z-pyramid, by the definition ascribed to it by the Examiner, would correspond to a tile Z value. The Office action clearly states this position where it notes that "respective Z-min and Z-max ... values for a given element [e.g., Fig. 5A element (tile) 512] are considered to represent a tile Z value range." (Office Action, p. 4). Thus, it is inconsistent to suggest that some such depth elements are tile Z value ranges while other depth elements are hierarchical Z value ranges.

More importantly, the Office action's characterization fails to address the problem with such an allegation. That is, the Office action brushes over the fact that Greene does not appear to compare any tile Z values or any depth element Z values with Z-values of a finer granularity level of the Z-pyramid and determining whether to render a plurality of pixels within the tile based in part on this comparison. Instead, Greene compares Z-values of a primitive to Z-values in the pyramid for the purpose of determining if such a primitive is hidden or at least partially visible (Col. 17, ll. 24-40), and builds the Z-pyramid by comparing Z-values only in the immediately preceding level (Col. 14, 53-56).

Thus, in summary, Greene appears to be directed to comparing the nearest Z-value of a given primitive (i.e., a single Z value of a primitive) to a Max-Z value and a Min-Z value in the

Z-pyramid for the purpose of determining if the primitive is hidden or at least partially visible. At no point does Greene appear to teach any sort of comparison to a hierarchical Z value range or any sort of determination whether to render pixels within the tile, in part, based on this comparison, as required by the claims.

### Aila

Aila fails to cure the deficiencies of Greene. The Office action admits as much. For example, the current Office action alleges that Aila teaches identifying tile Z-min and tile Z-max values as part of defining a tile volume. (Office action, pp. 2-3; Aila, ¶ 53). The current Office action also admits that Aila “fails to explicitly teach a hierarchical Z value range for which to compare said previously disclosed [tile] Z value range with.” (Office action, p. 3).

For purpose of discussion, Aila appears to describe a prior art method of performing a depth test that is performed on a pixel by pixel basis to determine if the polygon currently being drawn is in front of the polygon already stored for the pixel. (Aila, ¶¶ 6). The depth test is performed by calculating a depth value for each pixel in a polygon and comparing the calculated depth value for that pixel to a previously stored depth value. (*Id.*). Aila further teaches that for non-visible, non-real geometry, such as shadow volumes, tiles may be classified as non-boundary or potentially boundary tiles with respect to a shadow volume. (Aila, Fig. 4, Elements 404-406). If the tile is potentially a boundary tile, a shadow volume algorithm is performed on a per-pixel level; whereas if the tile is a non-boundary tile, the shadow volume algorithm can be carried out for one point within the tile to determine if the tile is fully lit or fully in shadow. (Aila, Fig. 4, Elements 405-411). To determine whether a tile is a non-boundary tile or a potentially boundary tile, Aila appears to use the results of the Early Occlusion Test unit 613, which determines if triangles (visible and non-visible) are hidden with respect to a tile volume or

intersect the tile volume. (Aila, ¶ 84). It appears that the Early Occlusion Test unit 613 uses the tile Z-max value for comparison with a depth value of the triangle. (Aila, ¶ 84 stating that the functionality of the Early Occlusion Test unit 613 “is done in order to perform occlusion culling using Z-max”). Aila does not appear to use the Z-min value for a tile for any purpose but identification of the tile.

Summarizing Aila, the Office action alleges that Aila teaches the identification of a tile using tile Z-min and tile Z-max values and further admits that Aila does not teach a hierarchical Z value range for which to compare the previously disclosed tile Z value range. Moreover, the Office action appears silent as to any use of the tile Z-min value. At best, the Office action merely establishing that the tile Z-max value can be used to determine whether a tile is a non-boundary tile or a potentially boundary tile.

#### Summary

Because each of Greene and Aila fails to teach any hierarchical Z-value range and further fails to teach any comparison of a tile Z value range to a hierarchical Z-value range and any determination of whether to render a plurality of pixels within the tile based, in part, on such a comparison, claim 1 is believed to be in proper condition for allowance.

Each of the independent claims contain similar limitations as claim 1 and were rejected under the same or similar rationale. For at least the reasons identified with respect to claim 1, the remaining independent claims are believe to be allowable over the cited publications.

Similarly, each of the dependent claims is believed to add additional novel and non-obvious subject matter and is believed to be allowable for at least these reasons and those identified above.

Applicants respectfully submit that the claims are in condition for allowance and respectfully request that a timely Notice of Allowance be issued in this case. The Examiner is invited to contact the below listed attorney if the Examiner believes that a telephone conference will advance the prosecution of this application.

Respectfully submitted,

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